Diet, Nutrition and Excretion of the Asiatic Races in Singapore.

No. 1, Medical Students.

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Introduction.

This research was undertaken in order to supply the local medical students with necessary information. Up to a short time ago the physiology of diet, nutrition and excretion which was placed before these students, was that of an European. The facts and figures which hold for an European are far from the truth when applied to an Asiatic. The results published in this paper have been obtained during the six months from October, 1916, to March, 1917, and although they are not considered to be more than an introduction to the subject they do form a basis to work upon when dealing with local Asiatic patients, whereas the European figures are certainly misleading. It is the intention of the author to continue this research for an indefinite period employing representatives of all classes and of all races of the community. These results apply to individuals leading sedentary lives similar to that of a medical student.

Technique.

There are Tamils, Malays, Chinese, Brahmins and Eurasians at the Medical School. One Tamil, one Chinese, and one Brahmin representative have been under observation every Monday, Wednesday and Friday for six months. A Malay has been employed for only two weeks. He partakes of the same diet as the Tamil. His results although few in number are interesting in that they confirm the results obtained from the Tamil. Results obtained at random from many other medical students confirm the results obtained from the students who have been under observation for six months.

The Tamil and Malay representatives live in the school hostel. The Chinese and the Brahmin live in their own homes. The Chinese, Brahmin and Tamil are senior students and rank amongst the most successful at the school. They have been demonstrators and class assistants for over a year. The author is indebted to them for their faithful co-operation.

In all cases the food eaten is that of the student's choice. The daily diet varies slightly in quality. It does vary considerably in quantity. The food was weighed just before it was eaten. The compositions of the foods and their heat values have been taken from standard books on the subject (1).

For estimations of the kidney excretions care was taken to preserve the twenty-four hour specimens by the addition of 2 c.c. of a 5 per cent. solution of Thymol in chloroform. This is a matter of importance to doctors in Malaya. Ammoniacal fermentation proceeds very rapidly in this climate if the preservative is not added. The methods of quantitative analyses employed are those described by Cramer (2). Some of these methods are not as accurate as they might be, but they are employed in most hospitals because the results obtained are quite accurate enough from a clinical point of view.

On one or two occasions one or other of the representatives was indisposed for a day or two. No observations were made until health was restored.

Diet and Nutrition.

Chinese.—The maximum diet taken by the Chinese in twenty-four hours gives a heat value of 2131 kilocalories. It consists of bread 45 grammes, condensed milk 42, boiled rice 798, flour 128, pork 77, chicken 32, fish 50, cabbage 10, bananas 112. His minimum diet for twenty-four hours gives a heat value of 1141 kilocalories. It consists of boiled rice 524 grammes, egg 40, pork 37, beans 14, chicken 51, flour 53, fish 21, cabbage 14, gruel 65. His average diet for six months consists of protein 60 grammes, fat 43, carbohydrate 227, which gives 1577 kilocalories (Table II). This student weighs 92 lbs. and is 20 years of age. He has lost a small amount of weight during the experiment. Examination of his kidney excretion shows that he metabolises 57.8 grammes of the protein eaten, so that he uses most of the food he eats.

Tamil.—The maximum diet taken by the Tamil in 24 hours gives 1847 kilocalories, his minimum diet 1519. The former consists of bread 116 grammes, butter 14, bananas 112, cake 112, cocoa 14, beef 21, mutton 98, boiled rice 448, egg 70, sugar 14. The minimum diet consists of bread 120 grammes, butter 6, bananas 67, fish 118, beans 154, boiled rice 504, cake 56, eggs 90, sugar 14, cocoa 14. This student lived on this diet for six months, but estimations were made during three months of this period. The average diet for the three months gives 1672 kilocalories and contains 58 grammes of protein, 32 of fat and 277 of carbohydrate (Table II). The examination of his kidney excretion shows that he metabolises 51.5 grammes of protein, so that he does not use all of the food he eats. He is 26 years of age and weighs 143 lbs.

Malay.—This student partook of the same diet as the Tamil's for six months. He has only been under observation for two weeks.

His average diet for this period contains 57 grammes of protein, 31 of fat and 239 of carbohydrate, the heat value being 1502 kilocalories (Table II). His kidney excretion shows that he metabolises 50 grammes of the protein of his food. He weighs 125 lbs. and is 18 years of age. His religion does not allow him to eat pork otherwise he has a free choice.

Brahmin.—The maximum diet taken by this student gives 2922 kilocalories, the minimum 2175. The maximum diet consists of wheat 96 grammes, lentils 107, rice (weighed uncooked) 350, butter 76, sugar 14, milk 448; the minimum diet consists of wheat 63 grammes, onions 49, butter 90, beans 126, lentils 140, rice 198, sugar 14, milk 336. The average diet contains 83 grammes of protein, 68 of fat and 371 of carbohydrate (Table II). Judging from his kidney excretion this student metabolises only half of his protein food, namely 41.5 grammes. The other half is simply wasted. It is well known that many vegetarians partake of such bulky and indigestible foods that absorption is interfered with. This student is a strict vegetarian; Brahmins are not allowed to take any animal food except milk. His average daily diet has a heat value of 2493 (Table II) but it is evident that he uses a good deal less than this since only half of the protein food is actually used by his body. He weighs 110 lbs. and is 21 years of age. He has not altered appreciably in weight during the six months of observation.

Kidney Excretions.

Ammonia.—The total acidity of the urine cannot be accurately determined, but if the urine be neutralised by adding $\frac{N}{10}$ alkali, some indication can be obtained regarding the acidity. Since the figure thus obtained is of no known clinical importance no more need be said about it. After neutralising the urine as above, neutral formaldehyde is added. Owing to the liberation of acid which takes place when the formaldehyde has combined with ammonia, the urine acquires again an acid reaction. This second acidity is titrated again with $\frac{N}{10}$ alkali and this second titration is a measure of the amount of ammonia present. The average quantity of ammonia excreted by the Chinese is .61 gramme, by the Tamil .63, by the Malay .66 and by the Brahmin .57. An European excretes about .7 gramme (Table I). The smaller quantity of ammonia excreted by the Asiatic is due to the fact that he eats a larger proportion of vegetables than the European. Vegetable foods are very rich in bases which unite with the acids of the blood and thus a smaller quantity of ammonia is required from the tissues in order to keep the blood alkaline. Ammonia formation is the physiological remedy for deficiency of bases and is excessive in certain diseases, *e.g.*, acidosis.

Chloride.—This is estimated by Volhard's method in which all the chlorides are precipitated with an excess of standard silver

Table I. KIDNEY EXCRETIONS (Average figures).

Subject.	Period of observation.	Ammonia.	Chloride.	Urea.	Total Nitrogen.	Ammonia Coefficient.	Amount.	Specific Gravity.
Chinese in Singapore	6 months	.61 gm.	5.27 gm.	16.00 gm.	9.25 gm.	5.4%	1273 c.c.	1012
Tamil in Singapore	6 months	.63 ,,	5.21 ,,	14.41 ,,	8.24 ,,	6.3 ,,	1629 ,,	1009
Malay in Singapore	2 weeks	.66 ,,	8.00 ,,	13.35 ,,	8.00 ,,	6.8 ,,	1335 ,,	1010
Brahmin in Singapore	6 months	.57 ,,	6.34 ,,	11.08 ,,	6.64 ,,	7.1 ,,	1396 ,,	1014
European in Europe (8)	....	.70 ,,	11.00 ,,	35.00 ,,	16.00 ,,	3.6 ,,	1500 ,,	1015
European in Singapore	1 week	1.06 ,,	8.10 ,,	25.00 ,,	15.30 ,,	5.6 ,,	1560 ,,	1012

nitrate; the excess of silver nitrate used is determined by adding standard solution of ammonium sulphocyanate in the presence of a ferric salt. The Chinese excretes 5.27 grammes, the Tamil 5.21, the Malay 8 and the Brahmin 6.34. An European excretes about 11 (Table I). On experimental diets individuals have been kept in good conditions when the total content in sodium chloride is reduced to 1 or 2 grammes per diem. Bunge has called attention to the fact that among men and animals the desire for salt is limited for the most part at least to those that use vegetable food. The potassium salts of the vegetable food react with the sodium chloride forming potassium chloride and a sodium salt, both of which would be excreted by the kidney. The blood will thereby lose some of its supply of sodium chloride, whence the craving for more in the food (3).

Urea.—The method employed calculates the amount of urea by measuring the amount of nitrogen liberated from the urine by sodium hypobromite. Doremus-Heinz ureometer is employed. This method only gives approximate results. The Chinese excretes 16 grammes per diem, the Tamil 14.41, the Malay 13.35, the Brahmin 11.08 whereas the average figure for an European is 35 (Table I). It is well known that the amount of urea depends upon the amount of protein absorbed so that the greater the quantity of absorbable protein in the diet the greater the quantity of urea in the urine. About 80% of the total nitrogen in the urine is excreted in the form of urea.

Total Nitrogen.—This is estimated by Kjeldahl's method. The Chinese excretes 9.25 grammes per diem, the Tamil 8.24, the Malay 8.0, the Brahmin 6.64, the European figure being 16 (Table I). It is considered accurate to take the nitrogen excretion as an indicator of the amount of protein actually metabolised or used by the body in performing its work. Since nitrogen forms about 16% of protein, the amount of nitrogen excreted multiplied by 6.25 gives the amount of protein metabolised. The figures thus obtained are 57.8 grammes of protein for the Chinese, 51.5 for the Tamil, 50 for the Malay, 41.5 for the Brahmin and 100 for the European. We have seen that the Brahmin eats a good deal more protein than the other Asiatics (Table II), nevertheless he uses a smaller amount in metabolism, so that evidently a smaller proportion of the protein of his food is absorbed. This is due to its bulk and its indigestibility.

Ammonia Coefficient.—This is the amount of nitrogen, excreted as ammonia, expressed in terms of percentage of the total nitrogen. In an European it is 3.6%, in the Chinese student 5.4%, in the Tamil 6.3%, in the Malay 6.8%, and in the Brahmin 7.1% (Table I). It is higher in the Asiatics than in the European because the protein intake is greatly reduced in the Asiatics so that there is a low total nitrogen excretion. Of the Asiatics the Brahmin has the highest coefficient because he excretes the smallest

TABLE II. DIET AND METABOLISM (Average figures).

Subject.	Diet.	Period of observation.	Weight.	Protein in food.	Protein from Nitrogen in urine.	Fat in Food.	Carbohydrate in food.	Kilocalories in food.
Chinese in Singapore	mixed	6 months	92 lbs.	60 gm.	57.8 gm.	43 gm.	227 gm.	1577
Tamil in Singapore	„	3 „	143 „	58 „	51.5 „	32 „	227 „	1672
Malay in Singapore	„	2 weeks	125 „	57 „	50 „	31 „	239 „	1502
Brahmin in Singapore	vegetable	6 months	110 „	83 „	41.5 „	68 „	371 „	2493
European (Ranke)	mixed	....	160 „	100 „	100.0 „	100 „	240 „	2324
Bengali (McCay)	mainly vegetable	....	115 „	67 „	....	72 „	549 „	3196
Anglo-Indian (McCay)	mixed	....	..	95 „	....	56 „	467 „	2826
Filipino (Aron)	„	....	115 lbs.	75 „	75 gm.	25 „	510 „	2632

amount of nitrogen, whereas the Chinese has the lowest coefficient because he excretes the largest amount of nitrogen.

Other Researches in the Tropics.

I am able to compare my results with those of two other observers. McCay has worked on the diet and nutrition of students in Bengal. He has found that the Bengali students take a smaller proportion of protein food than the Anglo-Indian students who are attending the same college. In opposition to Chittenden's views he attributes the better physique and greater muscular energy of the Anglo-Indian students to this fact. The Bengali student, who averages 115 lbs. in weight eats 67 grammes of protein, only a small quantity of which is obtained from animal sources, 72 of fat and 549 of carbohydrate. This diet has a heat value of 3196 kilocalories. The Anglo-Indian student eats 95 grammes of protein, a big proportion of which comes from animal sources, 56 of fat and 467 of carbohydrate. Although the Bengali eats a smaller amount of protein than the European, he is quite susceptible to kidney troubles (4). One is not justified in concluding that excess of protein is not harmful to the kidney, because there may be reasons to explain the kidney disease in the Bengali which are at present unknown. It is quite evident to physicians that the larger the amount of waste substance to be excreted by the kidney the more is the kidney taxed. In treating kidney disease there is no doubt that cutting down the protein excretion eases the kidney.

Aron (5) has made observations on Filipino students, with an average weight of about 115 lbs. They require 75 grammes of protein, 25 of fat and 510 of carbohydrate. This diet gives 2632 kilocalories (Table II).

Commentary.

As far as my experiments go they show that the medical students of Singapore require less food than the students of Bengal and the Phillipines (Table II). Probably this is due to the climates. In Singapore, Calcutta and Manila, the students wear the same tropical clothes, at least during the hot seasons. Therefore we can exclude the influence of clothes. Singapore has practically no seasonal change throughout the whole year; the temperature varies only slightly, the mean being 80°F. At Manila in the Phillipines there is some seasonal change, the months of November, December, January and February having a temperate climate. Bengal enjoys a winter. Again the humidity of the atmosphere is greater in Singapore than in Manila and much greater than in Calcutta. The climatic conditions in Singapore, therefore, are more likely to prevent the body losing heat, so that less food is required to keep up the body heat. The average weight in all three cases is about the same. The Singapore students do not take much muscular exercise. This is another probable cause of their small

diet and it may be due to the climatic conditions. Europeans are not inclined to take much exercise in the Tropics but they all do so, because it is not possible to keep healthy on an European diet without regular exercise. The writer has made observations (Table I) upon his own kidney excretion, the results showing that he partakes of a diet similar to that taken by him in Scotland. He takes a good deal more exercise in Singapore than he did in Scotland, although he always took an active interest in out-door games in the latter country. Sir Patrick Manson and others have indicated that even in the case of Europeans who do take active exercise, a diet of moderate quantity is necessary to maintain health in the Tropics, if long residence is contemplated. An excess of food materials throws too much work on the excretory organs and owing to the usual free diaphoresis, the fluids taken are insufficient to flush the kidneys properly, or to secure adequate excretion of the solid products by that channel. This inadequate excretion will in time injure all the organs (6). The smaller amount of food taken by the Singapore student may be nature's way of counteracting the evil effects of the climate.

Judging from McCay's research the physique and the muscular energy deteriorate on a small amount of protein. Therefore good physique and great muscular energy are incompatible with prolonged residence in a climate like that of Singapore. By prolonged residence is meant a generation or more.

Although the Singapore students who have been under observation do not possess the muscular energy of an European student, they have done quite as much brain work as the average European student. The author has had nine years experience with European students and four years experience with Singapore students. It has been shown that brain work does not require extra food; in other words, a lazy student is just as expensive to feed as an hard working student. A man doing hard mental work in Atwater's respiration chamber gave the same results as when he was resting. Intellectual work has not been found to have any demonstrable quantitative or qualitative effect upon the metabolism of man (7).

Ranke's standard diet for an European living a sedentary life in Europe is appended (Table II) for purposes of comparison.

The figures obtained by examination of the Asiatic student's kidney excretions can be explained by the fact that the Asiatic eats a smaller amount of nitrogenous or protein food than the European. It is not likely that these figures will differ very greatly in the hard working Asiatic coolie, because the coolie does not eat much more protein than the student, but he increases the carbohydrate content of his diet.

Conclusions.

1. The results obtained from examination of the kidney excretion of local students indicate that the European figures are of no value when dealing with Asiatic patients.

2. The total nitrogen varies from 6.64 grammes in the Brahmin to 9.25 in the Chinese.

3. The urea varies from 11.08 grammes in the Brahmin to 16.00 in the Chinese.

4. The ammonia varies from .57 gramme in the Brahmin to .66 in the Malay.

5. The ammonia coefficient varies from 5.4% in the Chinese to 7.1 in the Brahmin.

6. The chlorides vary from 5.2 grammes in the Tamil to 8 in the Malay.

7. The Singapore student partakes of a smaller amount of food than the Philippine or Bengali student. This seems to be due directly or indirectly to the climatic conditions of Singapore.

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